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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G09F 19/22, G03B 25/00, G09F 21/04, H05B 41/19 | A1

(11) International Publication Number: **WO 00/55835**

(43) International Publication Date: 21 September 2000 (21.09.00)

(21) International Application Number: PCT/GB00/00856

(22) International Filing Date: 9 March 2000 (09.03.00)

(30) Priority Data:
9905781.2 12 March 1999 (12.03.99) GB
9916433.7 13 July 1999 (13.07.99) GB

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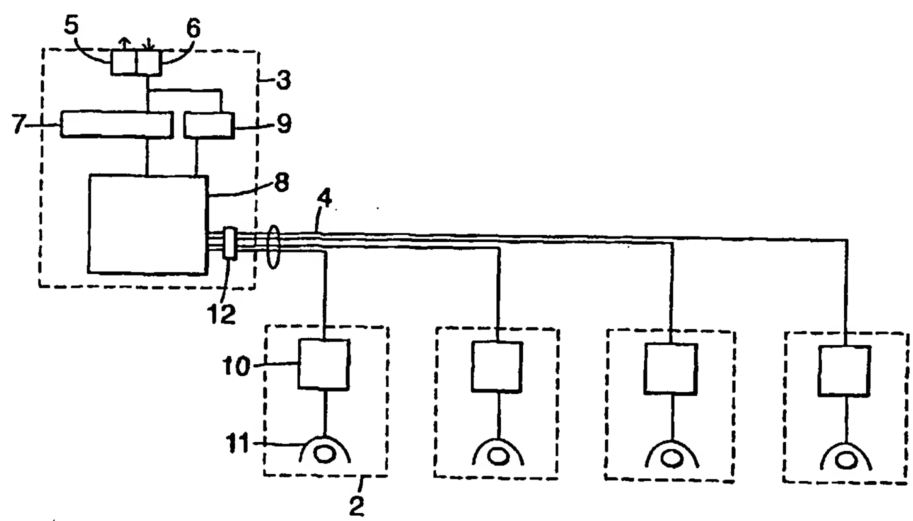
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: IMAGE DISPLAY SYSTEM



(57) Abstract

The present invention relates to an image display system for displaying images to passengers in a vehicle, for example a train. The image display system comprises an image display system comprising a series of images (1) for disposal along the path of a vehicle; discharge lamps (11) for briefly illuminating individual images; a plurality of control units (3). The control means comprises a detector (6) for detecting marking on the vehicle; a counter chain (7) for measuring a time difference as a measure of the speed of the vehicle and a microprocessor (8) for controlling the lighting of said at least one image in response to detection of the marking to illuminate each individual image repeatedly for respective windows of the vehicle taking into account the speed of the vehicle and the positions of the respective windows of the vehicle.

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IMAGE DISPLAY SYSTEM

The present invention relates to an image display system for displaying images to the passengers in a vehicle, for example a train.

There have been proposals for image display systems of the type comprising a series of images disposed along the path of a vehicle and lighting for briefly illuminating individual images successively as the vehicle passes. The illumination is sufficiently brief to prevent blurring of the image due to the motion of the vehicle when viewed by a vehicle passenger. Illumination of successive images as the vehicle passes causes the viewer to see the images as a single continuous image due to persistence of vision, in the manner of a television or cinema image.

Such an image display system is desirable as a means of displaying adverts or written and diagrammatic information, for example about the next station stop on a train route. However previous proposals have not succeeded as practical implementations due to technical difficulties in implementation, for example in triggering the illumination at the correct instant.

According to a first aspect of the present invention there is provided an image display system comprising a series of images for disposal along the path of a vehicle; lighting for briefly illuminating individual images; and at least one control unit for controlling the lighting of at least one image to illuminate images successively as the vehicle passes, wherein the at least one control unit comprises: detector means for detecting arrival of the vehicle; means for deriving a measure of the speed of the vehicle; means for controlling the lighting of said at least one image in response to detection of the marking to illuminate each individual image repeatedly for respective windows of the vehicle taking into account the speed of the vehicle and the positions of the respective windows of the vehicle.

The present invention provides accurate timing control of the illumination using a simple control system. By taking account of the vehicle speed and window positions, it is possible to control the illumination to illuminate each image at precisely the correct position relative to each of the respective windows so that the series of images may be viewed as a single continuous image through each of those

respective windows. Because the present invention allows the illumination to be controlled taking account of the actual positions of the respective windows, it avoids the problems in the known image display systems which merely illuminate the images at a rate in proportion with the speed of the vehicle. In such a known system the images are lit at an arbitrary position relative to any given windows and may therefore be obscured from the sight of a passenger in the vehicle.

Preferably the detector means is arranged to detect marking on the vehicle. Use of marking allows the system to be implemented with a minimal amount of modification to the vehicle. A single marking may be used to control the illumination for several windows, so it is not necessary to mark every window which is inconvenient and ugly.

Advantageously, the speed of the vehicle is derived from the output of the detector means. In this way it is possible to use the marking to derive the speed sufficiently accurately to illuminate the images at a consistent position relative to the windows so that there is no jitter.

Preferably, the lighting is not mounted on the vehicle which is inconvenient and undesirable because it involves cutting panels or otherwise modifying the vehicle. A display unit may mount the image and the lighting.

It is technically simple to derive a measure of the speed from the output of the detector means. This may be done for example by detecting a time difference in the output from the detector means. One possibility is to detect the time between two features of the marking a predetermined distance apart. The two features may be separate strips of tape or may be the beginning and end of a length of marking having a discrete length, such as a bar code. An alternative is to utilise two detectors a predetermined distance apart in which case the times difference between the detection of the same feature of the markings is detected. The advantage of this system is that it allows the measure of the speed of the vehicle to be derived from a single marking on the vehicle, such as a single strip of tape, which minimises the modification to the vehicle.

Preferably, the means for controlling the lighting comprises a microprocessor running a program to calculate the illumination timings for each individual image. A

microprocessor allows sufficiently accurate timing control to be implemented.

Desirably, the control unit is arranged to control the lighting of a plurality of images taking into account the positions of the images. This reduces the cost of the system because a separate control unit for each image is avoided. By taking account of the position of the images the illumination timings can be derived accurately even when the image spacing is not regular which is impossible in known systems which illuminate an image at a rate proportional to the speed of the vehicle.

Preferably, in said control unit said respective window positions are represented by the individual bits of a first bit pattern which represent the presence or absence of a window at positions a predetermined spacing apart and said respective image positions are represented by the individual bits of a second bit pattern which represent the presence or absence of images at positions said predetermined spacing apart, and said control unit is arranged to derive the timings for illumination of individual images in real time by relatively shifting the first and second bit patterns at a rate proportional to the derived speed of the vehicle and controlling the illumination of respective images when the bit of the second bit pattern representing the presence the respective image coincides with the bit of the first bit pattern representing the position of a window. For example the control unit may be arranged the control unit is arranged to shift said first bit pattern through a shift register and, using the second bit pattern to map the bit positions of the shift register to said plurality of images, to output the bits at bit positions of the shift register where the second bit pattern indicates the presence of an image to control illumination of that image. This is a particularly advantageous way of deriving the illumination timing, because it is simple yet reliable.

Preferably, the marking encodes the positions of windows along the vehicle and the control unit is arranged to decode the output of the detecting means to derive the window positions and to use the derived window positions to derive the illumination timings. Such use of encoded window positions facilitates the calculation of appropriate illumination timings thereby improving timing control. The illumination timings can be calculated easily from the decoded window positions because the appropriate timings are the positions divided by the speed of the vehicle.

Furthermore, simply by changing the encoded markings the system can accommodate different window configurations of different types of vehicle or the windows at which the images are visible may be selected.

The markings may be a bar code which is advantageous because bar code technology is in itself well developed and hence its use simplifies the present system.

Known image display systems have concentrated on illuminating each image in, as closely as possible, an identical position relative to a given window of the vehicle. This is indeed necessary to prevent jitter or drift in the image viewed by a passenger on a vehicle.

According to a second aspect of the present invention, there is provided a control means for an image display system for briefly illuminating successive images of a series of images disposed along the path of a vehicle as the vehicle passes, wherein the control means is arranged to control the lightly illuminate the images of respective portions of the series of images in positions which, relative to the vehicle, are different for subsequent portions.

The second aspect of the present invention allows different portions of the series of images to be viewed a passenger in the vehicle at different positions within the window from which the passenger is looking. This contrasts with the known systems in which the aim is to illuminated the images in an identical position. It allows numerous visual effects to be achieved, because the image viewed by the passenger may be moved around. For example, the images of the first portion of the series of images may be illuminated on one side of the window and the images of the second portion of the series may be illuminated on the opposite side of the window. This movement may be co-ordinated with the content of the images. For example, the portion of the series displayed on one side of the window may be images of a first person talking and the portion of a series on the second side of the window may images of the second person talking in order to give the impression of two people having on opposite sides of the window a conversation. Numerous other effects are possible with this technique. Within each portion of the series of images, it is desirable to illuminate each image in an identical position relative to the window, so that there is no jitter or drift.

According to a third aspect of the present invention, there is provided an image display system comprising: a series of images for disposal along the path of a vehicle; lighting for briefly illuminating individual images; and control means for controlling the lighting to illuminate images successively as the vehicle passes, wherein the series of images comprises a plurality of cyclically interleaved sequences of images.

By cyclically interleaving different sequences, the control means may be arranged selectively to display one of the sequences, in particular by only illuminating the images of that sequence. Thus if the sequences display different types of image the system can change the type of image shown, for example depending on the time of day, without the need to physically replace the images. This makes the system very versatile.

Alternatively, the interleaved sequences can be used to insert a subliminal image sequence into a main sequence or to create special effects by appropriate choice of the image sequences and, if necessary, control of the lighting.

The fourth aspect of the present invention relates to a capacitive discharge circuit for a strobe lamp in the type of image display system to which the present invention relates or to other systems where it is necessary to provide brief, bright illumination . In such an image display system, it is necessary to illuminate the image for a sufficiently brief time to prevent blurring which is caused by relative movement of the image whilst it is lit. For example, where the train is expected to move at a typical speed of 30 m/s, to limit the relative movement of the train and image to, say, 3 mm, the period of illumination, must be 0.1 ms.

Strobe lamps such as gas discharge lamps used in a capacitive discharge circuit are known for providing brief illumination in other applications. However, the known capacitive discharge circuits would be unduly expensive, large and impractical for the present type of image display system. This is because of the requirement for the illumination to be both brief and sufficiently bright for the viewer's eye to perceive a sufficient total amount of light for the image to be visible.

It must be noted that the brief period of illumination of the order of 0.1ms may be contrasted with a TV or cinema film where each frame is visible for a much

larger proportion of time. Therefore it is necessary that the discharge capacitor in the capacitive discharge circuit stores a large amount of energy to achieve a sufficiently bright flash. However, this can be incompatible with the charging requirements that the capacitor must be charged quickly without creating a high charging current. For example, at a typical train speed of 30 m/s and a typical window spacing of 2m, it is necessary for a given strobe lamp to flash at a rate of 15 Hz. However, charging the discharge capacitor this quickly to a sufficient level with a known capacitive discharge circuit creates a very high charging current which requires larger and more expensive components to tolerate the current and also increases the power supply requirements. In other words, the known capacitive discharge circuits do not meet the requirements of creating a sufficiently bright flash with sufficiently quick recharging without creating excessive charging current.

According to the fourth aspect of the present invention, there is provided a capacitive discharge circuit for a strobe lamp, comprising: at least one discharge capacitor for storing charge; a strobe lamp; a trigger circuit arranged to trigger discharge of the at least one capacitor through the strobe lamp; and a charging circuit for the at least one discharge capacitor arranged to charge the at least one discharge capacitor through an inductor in series with the at least one discharge capacitor.

The use of an inductor in the charging circuit overcomes the problems with modifying the known capacitive discharge circuits by allowing charging to a sufficient level without creating an excessive charging current. This results from the fact that the RC charging characteristic of a known capacitive discharge circuits creates an initially high current because of the exponential shape of the RC characteristic. In contrast, the present invention allows an LC charging characteristic to be employed which allows a faster charge time for a given maximum charging current because it is shaped as the initial part of a sine wave. The present invention is also more energy efficient because it is current limited by the inductance of the inductor, rather than by a resistive element.

Another advantage of the present invention is that it allows the inductor to be a fluorescent tube choke type inductor. In many capacitive discharge circuits, the cost of a sufficiently large inductor would be prohibitive, but it has been appreciated

with the operating characteristics of the strobe lamps in an image display system allow the use of a fluorescent tube choke type inductor which is cheap and easily available.

Another advantage of the inductor is that it allows the energy of the inductor to be fed forward to the at least one discharge capacitor to increase the operating voltage. This reduces the required capacitance of the discharge capacitor for a given energy output. For example, this may be achieved by the charging circuits including at least one reservoir capacitor having a capacitance greater than said at least one discharge capacitor connected in parallel with the series assembly of said at least one discharge capacitor and said inductor.

Preferably, the charging circuit includes a switch arranged to disconnect the at least one discharge capacitor from the charging circuit during discharge of the at least one discharge capacitor, for example by the trigger signal provided the trigger circuit being also supplied to the switch. This prevents the current from the charging circuit being fed to the strobe lamp during discharge, which would be undesirable because it would impose the duty cycle of the supply on the output of the strobe lamp and could cause the lamp to enter a mode of operation harmful to the lamp.

Desirably, the trigger signal is supplied to the switch through an optocoupler in the form of an opto-triac. This has the advantage that the switch is only re-enabled at the zero-crossing point of the mains cycle, removing the need for a resistor in the charging circuit and thereby improving energy efficiency.

The capacitive discharge circuit may comprise more than one strobe lamp. In that case each strobe lamp preferably has separate discharge capacitors and separate trigger circuits, but this is not essential.

According to the fifth aspect of the present invention there is provided a display unit for mounting an image for display on the unit and for use in an image display system in which the image is briefly illuminated, wherein the display comprises: lighting arranged to briefly illuminate the image; and a shutter for controlling the duration of illumination provided by the lighting.

The shutter may be open to start illumination and/or close to stop the illumination. This is advantageous because many types of light, for example a gas

discharge element, are difficult to quickly light and/or extinguish by control of the power supply alone, which can make it difficult to efficiently limit the duration of illumination. If the lighting has a significant rise time or fall time for the illumination levels, the shutter can be used to cut out illumination during at least part of the rise and/or fall to provide illumination predominantly at a high level.

Any or all of the aspects of the present invention may be applied in combination.

To allow a better understanding of the present invention, the following description of an image display system which embodies all the aspects of the present invention is given by way of non-imitative example with reference to the accompanying drawings in which:

Fig. 1 is a view of a section of the image display system;

Fig. 2 is a diagrammatic view of the circuitry of the section of the image display system;

Fig. 3 is a view of an alternative control unit for the section of the image display system;

Fig. 4 is a flow chart for the control program run in the control unit;

Fig. 5 is a side view of a display unit of the image display system;

Fig. 6 is a cross-sectional view of the display unit of Fig. 5 taken along the line Xi-Xi;

Fig. 7 is the circuit diagram of a capacitive discharge circuit for the lighting of the image display system;

Fig. 8 is a graph showing charge curves for the capacitive discharge circuit;

Fig. 9 is a cross-sectional view of a first alternative construction for the display unit; and

Fig. 10 is a cross-sectional view of the second alternative construction for the display unit.

The image display system is arranged to display images to viewers on a vehicle such as a train. A section of the image display system is illustrated in Fig. 1 which shows the elements mounted adjacent the path of the vehicle, for example adjacent a railway track. The section comprises a plurality of images 1 each mounted

in a display unit 2 which has lighting (described in more detail below) for briefly illuminating the individual images. The lighting is controlled by a control unit 3 connected to the display units 2 by respective control lines 4.

The section controlled by the control unit 3 can include any number of images 1. Although only four images 1 are illustrated in Fig. 1 for clarity, desirably the number is large, typically 24, to reduce the number and hence cost of the control units 3. The image display system may comprise a single section as illustrated in Fig. 1, or plural successive sections to display an image for a longer time.

The images 1 are of a suitable size to be seen through a single window of the vehicle, for example A2 where the vehicle is a train.

The images 1 together form a series which shows a stationary or changing image when viewed successively. The change may create motion in the viewed image for example like the bouncing ball shown in Fig 1, or may be a colour change or other visual effect. The images 1 may show an advert or useful written or graphic information, for example about the next stop for the vehicle.

Desirably, the images 1 include at least one horizontal line (not shown) at a predetermined vertical position relative to the image, preferably continuous lines running above and/or below the main image. Such lines will be picked out by the eye of the viewer and act as a guide to compensate for vertical displacement of successive images, for example because of their mounting position or because of rocking of the vehicle. The lines may be invisible to normal illumination and picked out by a separate ultra-violet lamp.

The display units 2 illustrated in Fig. 1 are wall-mounted at the height of the vehicle windows, for example on the wall of a tunnel or a cutting, although free-standing display units could be used where there is no suitable mounting surface. Often the images 1 need to be fitted around obstacles along the path of the vehicle such as alcoves in a tunnel. In this case, the gap between images 1 might increase but this creates a minimal disturbance to the viewed image and simply alters the frame rate at that point in the series of images 1.

The circuitry of the information display system is illustrated in Fig. 2 in which the location of the various elements in the display unit 2 and the control unit 3

is shown schematically by the dotted boxes.

The control unit includes an infra-red laser diode 5 as a source of electromagnetic radiation arranged to be incident on a passing vehicle. The control unit 3 further comprises a detector 6 in the form of a matched infra-red receiver for detecting any radiation from the laser diode 5 reflected from the vehicle. Marking is affixed on the vehicle at a predetermined position level with the detector 6. Use of infra-red radiation reduces the chances of false triggering for example by the internal vehicle lighting and prevents the radiation being visible. A refinement is to use polarisation to prevent spurious signals triggering the detector 6. For example polarising reflective marking may be used with the detector 6 being sensitive only to polarised radiation.

The control unit 3 further includes a microprocessor 8 which runs a program to calculate when to illuminate each image 1 in response to the output of the detector 6 and outputs control signals at the calculated timings to trigger the illumination. The microprocessor also performs control and monitoring functions for the elements of the control unit 3.

In particular, the microprocessor 8 uses the output of the detector 6 to detect arrival of the vehicle, to derive a measure of the speed of the vehicle and to determine the positions of the windows on the vehicle relative to the marking.

For the purpose of speed measurement, the marking includes two vertically extending strips of reflective tape a predetermined distance d apart. Passage of the strips past the detector 6 cause pulses in the output of the detector 6. The time difference T between the two pulses acts as a measure of the speed v of the vehicle, because $T = d/v$. The output of the detector 6 is connected to a counter chain 7 which measures this time difference T between the two pulses. The measured time difference T is then supplied to the microprocessor 8.

The marking also encodes the window positions. For this purpose, the marking includes a bar code disposed immediately after the two strips of tape. The output of the detector 6 is fed to bar code chip set 9 which is in itself of a conventional, commercially available type. As the bar code on the vehicle passes, the output of the detector 6 is modulated by the bar code signal upon reflection of the

electromagnetic radiation from the bar code. The bar code chip set 9 decodes the bar code. The decoded bar code is supplied to the microprocessor 8 which uses it to determine the window positions. In particular, the control unit 3 has a memory table storing different sets of window positions for respective bar codes and uses the decoded bar code to look up the memory table. This may be stored in an involatile memory of the microprocessor 8, such as an EPROM.

Other forms of marking may be used to derive the measure of the speed of the vehicle. For example, instead of using two strips of tape as the two features to derive the time difference T, any features recognisable in the output of the detector 6 could be used, for example the beginning and end of a horizontally extending reflective strip. Alternatively, the two features could be the beginning and end of the bar code which would be advantageous because it would avoid the need for the reflective strips therefore reducing the amount of marking on the vehicle.

Alternatively, the detector 6 could comprise two separate detection units 6a and 6b a predetermined distance d apart, in which case the time difference T between the detection of a single feature by the two detection units could be used as the measure of the speed v of the vehicle. Fig 3 shows the arrangement of such a control unit 3, this being an alternative to the control unit 3 of Fig. 1. Fig 3 shows separate laser diodes 5 for each detector unit 6a and 6b but the sources could be arranged on the opposite side of the train track so the train interrupts them and there is no reflection. As this arrangement allows the speed to be measured from a single feature, such as a single strip of reflective tape at the beginning or end of bar code, it is advantageous because it reduces the amount of marking on the vehicle.

Instead of using marking, the speed of the vehicle could be measured in some other way, for example using a radar or acoustic measurement system.

In the arrangement described above, the control unit marking encodes the window positions and derives the window positions from the marking. This is advantageous because it allows the system to be used with different vehicles having different window configurations, but is not essential. If the image display system is to be used at a site where the vehicles have windows in identical, known positions the window positions may be stored in the control unit 3, for example in the

involatile memory of the microprocessor 8. The window positions specific to that site are then stored in the control unit 3 when the image display system is set up.

Alternatively, the information representing the window positions may be transmitted by some other means such as a transponder mounted on the vehicle. In that case the modules will have a receiver to receive the information and communicate it to the microprocessor 8. A vehicle transponder and display system receiver or transceiver may also be used to communicate other information between the train and control unit, for example control information, such as for selecting illumination of one of a plurality of interleaved sequences of images. Therefore, the bar code chip set 9 is optional.

The presence and form of the marking is not essential. For example, the arrival of the train could be detected in some other way such as from the change in the output of the detector on arrival of the front end of the train or some other feature already present on the side of the train. Other forms of detector 6 could be used. For example the detector need not use infra-red radiation. Also the system it need not rely on reflected radiation. The source could be arranged on the opposite side of the train so that the train interrupts a beam to detect arrival or could be omitted altogether if the detector 6 relies on ambient radiation.

Where the vehicle comprises a plurality of linked carriages, it is possible to provide separate markings on different carriages, whereby illumination is controlled independently for the different carriages in response to the separate markings. This allows the system to use a separate measure of the speed for each carriage which allows for more accurate timing control where the carriages pass the images at slightly different speeds, for example if the train is accelerating or decelerating or there is movement in the coupling between the carriages.

The program run in microprocessor 8 is illustrated in the form of a flow chart in Fig. 4.

In step S1 the microprocessor 8 monitors the output of the detector 8 to check the first feature of the marking, repeating step S1 until this occurs.

When the first feature is detected, the program proceeds to step S2 in which the output of the detector 6 is monitored to check for the second feature of the

marking. If this is not detected, the program proceeds to step S3, in which the microprocessor 8 monitors the output of the counter chain 7 to determine if the elapsed time since detection of the first feature has exceeded a threshold. If not, the program repeats step S2. The threshold is set at a level a little above the maximum expected time difference T. If the elapsed time exceeds the threshold before the second feature is detected, then the program reverts back to step S1 to look for the first feature of the marking once again. Thus the threshold prevents the illumination of the lighting from occurring erroneously in the event of a spurious signal appearing on the output of the detector 6.

If the second feature is detected in step S2 before the elapsed time exceeds the threshold, then the program proceeds to step S4. In step S4 the microprocessor 8 inputs the time difference T between the two pulses from the counter chain 7 as the measure of the speed of the vehicle.

Finally, in step S5, the microprocessor 8 determines the appropriate illumination timings and transmits control signals on control lines 4 at those timings to cause illumination of the images 1 in the respective display units 2.

The microprocessor 8 derives the timings for illumination of each image 1 connected thereto to illuminate each image repeatedly for different windows of the vehicle. This is to allow the sequence to be viewed from each of those windows. To perform this calculation, the microprocessor 8 takes into account the positions, x_w of each window relative to the marking, in particular by dividing the position x_w by the measured speed of the vehicle. As the control unit 3 normally controls plural images 1 at different positions, the microprocessor 8 also takes into account the positions x_i of the images 1 relative to the detector 6. In general, the timing $t_{i,w}$ at which to illuminate the ith image at position x_i for the wth window at position x_w can be derived from the measured time difference T by the following equation:

$$t_{i,w} = (x_i + x_w) \cdot \frac{T}{d} \qquad (1)$$

By storing the image positions x_i accurately, it is possible to control the timing for each image 1 of the sequence to be illuminated at an identical position

relative to any given window. This prevents sideways shifting of the viewed image from one image 1 to the next which can create drift relative to the window. For the same reason, it is important for a consistent value of the window position x_w to be used for all the display units 2, in the sequence even those controlled by different control units 3. However, the relative values of the window positions x_w are less critical as it is acceptable if the images are viewed at slightly different positions relative to different windows, provided they are still visible through the windows and each image is illuminated in the same position relative to any individual window.

Instead of all the images being viewed at an identical position relative to the given window, the timings may be controlled to illuminate the image or respective portions of the series of images in positions relative to the vehicle which are different for the respective portions. This may be achieved by adding selective offsets to the stored image positions x_i in equation (1) above. This technique allows many visual effects to be achieved, because the image viewed by the passenger may be moved around. For example, the images of the first portion of the series of images may be illuminated on one side of the window and the images of the second portion of the series may be illuminated on the opposite side of the window. This movement may be co-ordinated with the content of the images. For example, the portion of the series displayed on one side of the window may be images of a first person talking and the portion of a series on the second side of the window may images of the second person talking in order to give the impression of two people having on opposite sides of the window a conversation. Numerous other effects are possible with this technique. Within each portion of the series of images, it is desirable to illuminate each image in an identical position relative to the window, so that there is no jitter or drift.

Alternatively, the timings may be controlled to illuminate successive images at gradually changing position relative to a respective window. This may be achieved by adding a gradually changing offset to the stored image positions x_i in equation (1) above. This technique causes the viewer to see a motion image which itself moves relative to the window.

In general, there are many ways a microprocessor 8 could handle the

calculation of appropriate timings in step S5, but the preferred technique used in the described embodiment is as follows.

The respective window positions x_w are represented by a bit pattern known as the "train map". The individual bits of the train map represent the presence or absence of a window at positions a constant, predetermined spacing r apart. If the train map is 10100101, this would represent the windows at being at positions $x_w = r, 3r, 6r$ and $8r$.

Similarly, the respective image positions x_i are represented by a bit pattern known as the "tunnel map". The individual bits of the tunnel map represent the presence or absence of an image 1 at positions the predetermined spacing r apart. For example, if the tunnel map was 00101001, then this would represent a presence of images at positions $x_i = 3r, 5r$ and $8r$.

The train map and tunnel map are used to derive the illumination timings in real time by relatively shifting the two bit patterns at a rate proportional to the speed of the vehicle and proportional to the ratio of the predetermined distance d and the predetermined spacing r, whereby coincidence of respective bits of the tunnel map and train map occur when the corresponding window and image 1 are adjacent one another. The corresponding image is illuminated when this coincidence occurs. This is achieved by shifting the tunnel map along a shift register clocked at a predetermined shift timing t_s given by the equation:

$$t_s = \frac{r}{d} \cdot T \qquad (2)$$

The tunnel map maps individual bit positions of the shift register to respective images 1. The tunnel map is used to switch bit positions of the shift register to the control lines 4 for respective images 1. The bits of the shift register at bit positions where the tunnel map indicates the presence of an image 1 are used as the control signal and connected to the respective control line 4 of the corresponding image 1.

Therefore, the use of the shift register automatically creates control pulses in

real time on the control lines 4 at the correct timings. The shift register is a desirable way to achieve this because it allows the timings to be derived with a minimum amount of processing power and avoids the need to calculate and store all of the timings for all the images and windows as an initial step. It also handles the supply of simultaneous control signals to different images 1, because the bits are fed out of the shift register along the different control lines 4 in parallel with one another.

The size of the predetermined spacing r is the resolution of the window map and tunnel map. Any value for the predetermined spacing r may be chosen depending on the requirements for display on the vehicle and the site for the image display system in question. In general, it is desirable to use a low predetermined spacing r to avoid restriction on the positioning of the display units 2. This has the overhead of increasing the length of the bit patterns constituting the train map and tunnel map, but such long bit patterns are nonetheless easily handled by the microprocessor 8.

The control signals output from the microprocessor 8 are fed to the control lines 4 through an array of driver circuits 12 arranged to convert the level of the digital control signals to a sufficient level for the control lines 4.

Each display unit 2 houses a capacitive discharge circuit 10 which fires the lighting 11 to illuminate the image 1 in that display unit 2. The form of the capacitive discharge circuit 10 and the lighting are described in detail below. Each of the control lines 4 is connected to and triggers the capacitive discharge circuit 10 of a single display unit 2.

The display unit 2 is illustrated in Figs. 5 and 6. The base of the display unit 2 is performed by an open-topped box 17 formed from sheet-metal which is mounted in any orientation to a mounting surface adjacent the path of the vehicle. The open surface of the box 17 is covered by a transparent base sheet 13 of glass. The image 1 is transparency positioned on the base sheet 13. The display unit 2 has a hinged frame 14 supporting a transparent cover sheet 15 of glass. The frame 14 is openable (as shown in Fig. 5) to allow removal and insertion of an image 1 and closable to hold the image 1 sandwiched between the base sheet 13 and cover sheet 15. The capacitive discharge circuit 10 is formed on a printed circuit board 16 mounted to the

base of the box 17. The lighting 11 must be illuminated for a period of time sufficiently brief to prevent blurring of the displayed image when viewed from the vehicle. In effect, the image is perceived by the viewer to move by an amount equal to the speed of the train multiplied by the period of the illumination and this movement can blur the image. Therefore the period must be short relative to the speed of the vehicle preferably of the order of 1ms or less, preferably 0.5ms or 0.1ms or less.

The level of illumination must be sufficiently high to make the image 1 visible despite the brief period of illumination. The image display system will work in any ambient light conditions, including daylight, provided the illumination is sufficiently intense relative to the ambient light. Therefore, the intensity of the lighting is selected to be sufficient for the ambient light where the system is to be used.

To meet these requirements, the lighting consists preferably of at least one xenon discharge lamp 11, although other gas discharge lamps or strobe lamps could be used. In the embodiment the lighting consists of four xenon discharge lamps 11 mounted, both physically and electrically, to the printed circuit board 16. The discharge lamps 11 are spaced around the periphery of the printed circuit board 16 to spread the light generated by the discharge lamps 11 across the rear face of the image 1.

The capacitive discharge circuit 10 is designed to meet the above requirements for brief, bright illumination, as follows. The circuit diagram of the capacitive discharge circuit 10 is illustrated in Fig. 7. For clarity, the circuit diagram of Fig. 7 shows only a single discharge lamp 11, whereas in fact all the circuit elements shown in the dotted line in Fig. 7 are replicated for each discharge lamp 11 in parallel with one another.

Each discharge lamp 11 has two discharge capacitors, in particular a main discharge capacitor C3 and an attack discharge capacitor C2. The main discharge capacitor C3 is a substantial electrolytic capacitor (typically 33 to 100 μF and preferably 68 μF) which provides the main energy source for the discharge that lights the lamp 11. The main discharge capacitor C3 has a low internal resistance and is

formed to withstand the high current impulse requirements during discharge. The attack discharge capacitor C2 is a smaller device (preferably 0.1 or up to, say, 1 μF) which is non-electrolytic and has a very low internal resistance and inductance for the purpose of providing a faster attack to the flash dynamic characteristics. The discharge capacitors C3 and C2 are connected in parallel with the xenon discharge tube 11.

The control line 4 is connected to a terminal 19. The control signal from the microprocessor 8 is supplied from the terminal 19 to a thyristor TH1 through a first optocoupler O1 of a conventional transistor type. The thyristor TH1 forms part of a triggering circuit together with a resistor R2, a capacitor C4 and a transformer T1 connected in a conventional manner to provide an EHT trigger pulse to the discharge lamp 11, thereby to trigger discharge of the discharge capacitors C3 and C2 through the lamp 11.

The capacitive discharge circuit 10 further includes a charging circuit for charging the discharge capacitors C2 and C3 from an AC 240V mains supply connected to a pair of terminals 18. The charging circuit includes a bridge rectifier D1 to rectify the mains supply and provide a rectified DC supply across positive and negative supply rails 27 and 28. The rectified DC supply is supplied to the discharge capacitors C2 and C3 through a diode D2 and an inductor L1 in series with the discharge capacitors C2 and C3. The inductor L1 is a conventional fluorescent tube choke type. The ability to use this type of inductor would provide significant cost saving as it is far cheaper than any other type of inductor of a comparable size.

A switch S1, in the form of a transistor switch which may be implemented by bipolar or MOSFET transistors, is connected in series with the inductor L1. The switch S1 has the purpose of disconnecting the discharge capacitors C2 and C3 and the lamp 11 from the supply when the lamp 11 is triggered. Therefore, the switch S1 is switched on the inverse phase of the control signal supplied to thyristor TH1 by supplying the control signal from the terminal 17 to the switch S1 through a second octocoupler O2 normally of a conventional transistor type. This prevents current from passing directly to the lamp from the supply during illumination of the discharge lamp 11. This prevents the duty cycle of the supply being imposed on the

output of the strobe lamp and prevents the strobe lamp 11 from entering a harmful mode of operation.

In addition, the main supply is fed to the bridge rectifier D1 through a resistor R1, and there is a reservoir capacitor C1 connected between the positive and negative supply rails 27 and 28. The current limiting resistor R1 and the reservoir C1 are optional, for reasons discussed below.

The operation of the capacitive discharge circuit 10 will now be described.

After the mains supply is applied, current passes through the diode D2, inductor L1 and switch S1 to charge the discharge capacitors C2 and C3 until the voltage prevents current flow through the diode D2. Under normal conditions this voltage is in the range of 270V to 400V. This is the quiescent condition of the capacitive discharge circuit 10.

When the control signal is supplied to the control terminal 19, the discharge lamp 11 is triggered causing the charge on the discharge capacitors C2 and C3 to discharge through the lamp 11 creating the brief period of illumination required. Of course, all four strobe lamps 11 are triggered at the same time. During this time, the switch S1 is switched off by the control signal, thereby disconnecting the supply from the lamp 11 so that the only current flowing through the lamp 11 is the discharge current from the discharge capacitor C2 and C3.

Immediately after the trigger is removed, the switch S1 closes and the discharge capacitor C2 and C3 are charged via the inductor L1. The use of the inductor L1 in the charging circuit provides a number of advantages, as follows. The charging characteristics are determined by the predominantly LC circuit formed by the combination of the inductor L1 with the discharge capacitors C2 and C3. The resultant LC charge curve 20 is illustrated in Fig. 8 and is characterised by the initial part of the sine curve. Accordingly, the charge time to peak voltage is quick but without creating an excessive charging current. Control of the charging current is important as an excessive charging current may damage components. The charging current is proportional to the slope of the charge curve because it is equal to the total capacitance of the discharge capacitors C2 and C3 multiplied by the rate of change of voltage. It can be seen from Fig. 8 that the LC charge curve 20 is nearly linear over

the charging.

This contrasts with the charging of a conventional capacitive discharge circuit through a resistor which will have an RC characteristic. A typical RC charge curve 21 is also illustrated in Fig. 8. As compared to the LC charge curve 20, it can be seen that the charging time is longer whilst the maximum charging current is higher, at the beginning of the RC charge curve 21 where the slope is maximum. If the charge time of the RC charge curve 21 were to be reduced by decreasing the resistence in the charging circuit, then the charging current would become higher still. Therefore, the use of an inductor in the charging circuit adds an improved balance between obtaining a fast charge time without creating an excessive charging current.

In addition, the provision of the inductor L1 means that current is limited by the reactance of the inductor L1, rather than by a resistive element, so there is less energy wastage.

Furthermore, the use of the inductor L1 allows the energy stored in the inductor L1 to be fed forward to the discharge capacitors C2 and C3 in order to increase the operating voltage of the system as a whole. This reduces the size of the discharge capacitors C2 and C3 required for a given output energy. As the energy is directly proportional to the capacitance of the discharge capacitors, but proportional to the square of the voltage, this allows for far smaller capacitors and therefore produces significant cost savings.

To utilise the energy stored in the inductor in this way, the charging circuit includes the reservoir capacitor C1 connected across the supply and therefore in parallel with the series assembly of the discharge capacitors C2 and C3 and the inductor L1. The reservoir capacitor C1 is a large electrolytic capacitor (preferably 220 μF) having a capacitance significantly larger than the discharge capacitors C2 and C3 which conversely have a lower capacitance than if the reservoir capacitor C1 were omitted. The reservoir capacitor C1 filters the rectified DC supply voltage and provides a filter peak DC voltage which is higher than the RMS mains value.

During operation, the magnetic energy stored in the inductor L1 is fed forward to the discharge capacitors C2 and C3 during the charging cycle which has the effect of more rapid recovery of the reservoir capacitor C1 and the discharge

capacitors C2 and C3, and also maintains a higher overall voltage across the discharge capacitors C2 and C3.

In this arrangement, the current-limiting resistor R1 is provided in series with the AC supply to stop the in rush current to the reservoir capacitor C1 being excessive at power up and during operation. Optionally, a small capacitor (not shown) of say 100 μF may be connected in parallel with the rectifier D1 on the input, unrectified side.

The provision of the reservoir capacitor C1 and resistor R1 is preferred for modes of operation where the strobe lamp 11 will operate at a high frequency, for example above about 15Hz. However, at lower flash rates, it is not necessary to provide the reservoir capacitor C1, thereby providing a cost saving. In this case, optocoupler O2 is preferably an opto-triac which is switched on to disable the switch S1. This has the advantage that the switch S1 is the only re-enabled at the zero crossing point of the mains cycle. This gives a soft start and hence removes the need for the current limiting capacitor R1 which improves energy efficiency.

Numerous modifications may be made to the capacitive discharge circuit 10 illustrated in Fig. 7, as follows.

In place of separate optocouplers O1 and O2, a single optocoupler (either a transistor circuit or an opto-triac) may be used both to trigger the strobe lamp 11 and to control the switch S1. Preferably, the single optocoupler is arranged to connect a further charged capacitor (not shown) to the gate of the thyristor TH1 when switched on, in order to pulse the control signal applied to the thyristor TH1. The further charged capacitor may be connected directly to the control input of the switch S1. In this case a further resistor will be arranged in series in the line from the charged capacitor to the thyristor TH1 to provide an appropriate time constant to the pulse. For example, the further capacitor and further resistor may have values of 10 nF and 1.5 kΩ, respectively. The further capacitor then remains discharged whilst the optocoupler is on, thereby disabling switch S1 in the usual manner. For charging, this further capacitor may be connected in series with a larger resistor (of say 150 kΩ) between the positive and negative supply rails 27 and 28, so that the rectified DC supply smoothed by the reservoir capacitor C1 charges the further capacitor through

the larger resistor. Preferably the voltage on the further capacitor is limited for example by a Zener diode. Pulsing the supply to the thyristor TH1 has the advantage that the thyristor is not held on. This modification requires that the common terminal of the transformer T1 should be tied to the negative rail 28 rather than to the cathode of the strobe lamp 11 as illustrated in Fig. 7.

The unsmoothed supply voltage may be connected, through an appropriate diode and resistor, as an additional supply to the optocouplers O1 and O2 (or single optocoupler if used) and/or to the thyristor TH1 to ensure that these devices can never remain locked on if a fault in the circuit occurs.

Instead of providing the resistor R2, capacitor C4 and transformer T1 separately for each strobe lamp 11, a common trigger circuit may be used to trigger the strobe lamp 11, or the resistor R2 and capacitor C4 may be provided in common for all four strobe lamps 11, to feed respective transformers T1.

For safety, large resistors (of say 330 kΩ) may be connected in parallel with the discharge capacitors C2 and C3 and with the reservoir capacitor C1 to allow leakage of the charge stored on these capacitors when the capacitive discharge circuit 10 is disconnected from the mains AC supply.

Lastly, an additional diode (not shown) may be connected with its anode to the node between the switch S1 and the inductor L1 and its cathode to the positive supply rail 27. The operation of such a diode only becomes significant if the operating frequency becomes higher than anticipated in which case the switch is turned off before the capacitors have fully recharged. In this situation, such a diode will prevent damage to the switch due to over-voltage. It also has the advantage of feeding the excess energy from the inductor L1 back to the reservoir capacitor C1.

The series of images 1 may comprise a plurality of cyclically interleaved sequences of images 1. For example two sequences showing different motion images may be alternately positioned along the series. This allows one of the sequences to be selectively displayed, under the control of the microprocessor 8. This makes it very easy to change the image shown without having to physically replace the images. The change may be controlled, for example, based on the time of day.

Preferably, the microprocessor 8 monitors the illumination rate of individual

images to cut out illumination when the rate falls below a threshold. The threshold may be selected at a rate sufficiently low to cause harm or nuisance to viewers in the vehicle or at a rate sufficiently low to cause flickering of the image. In general, the threshold does not have a universal value, but varies with the flash and ambient lighting levels, but a typical cut-out level might be 16 or 20 illuminations per second.

An optional feature which may be added to the system described above is some means for drawing the attention of the viewer to an imminent sequence of images. This can maximise the impact of the display and prevent the viewer missing the initial images of a sequence. One possibility for such means is a display unit 2 of the type described above positioned in front of a sequence of images and showing a image which is brightly coloured or patterned or otherwise eye-catching. Another possibility is an arrangement of lights arranged in front of a sequence of images. The lights may be coloured and/or flash. They may be vertically displaced from one another to produce a streaming effect. The lights may be triggered by a control system similar to that of the display unit 2 described above or a simpler control system which merely detects the moving train or markings. Alternatively, means for producing an audio warning, such as a chime, voice or music may be used.

The image 2 may be darkened to reduce the visibility of the image when it is not illuminated. This reduces blurring which is caused by the images being visible to some extent even when not illuminated due to reflection of stray light, for example from the vehicle. This slight visibility creates blurring as the image moves relatively past the window. A preferable way to darken the image is to make either or both of the base sheet 13 or cover sheet 15 in the display unit 2 from darkened material. Alternatively, the image 1 can itself be darkened. Where the image 1 is darkened, it may be necessary to increase the level of illumination from the lighting 11 to compensate.

Other forms of display unit 2 may be used.

An alternative structure of the display unit 2 is shown in Fig. 9. In this structure, the images 1 are held in a closed sheet-metal box 22. A lighting 11 is disposed behind and below the image 1 and a reflector 23 behind the image 1 directs the light from the lighting 11 through the image 1.

Another alternative structure for the display unit 2is shown in Fig. 4. The images 2 are mounted to the major surface of a transparent sheet 24. A housing 25 attached to the lower rim of the sheet 24 houses a lighting 11 which emits light into the edge of the sheet 24.

The light is directed through the sheet 24 by total internal reflection and is emitted through the major surface of the sheet 24 and hence illuminates the image 1. By etching the major surface of the sheet 24 it is possible to control how much light is emitted. Preferably the etching causes the proportion of the incidental light emitted to increase relative to the proportion internally reflected as the distance from the lighting 11 increases so as to make the absolute amount of light emitted through a given area more uniform. The advantage of using sheet 24 to direct the light internally is that it can reduce the thickness of the module as compared to the use of a reflector.

Optionally, a shutter is provided to assist in controlling the brief illumination of the image 1. Such a shutter 26 is illustrated in Figs. 9 and 10 positioned between the lighting 11 and the optical system which directs light from the lighting to the mounted image, that is the reflector 23 in the display unit 2 of Fig. 2 or the transparent sheet 24 in the display unit 2 of Fig. 10. The shutter 26 is preferably an optical element having a controllable transmissivity, such as a liquid crystal shutter.

In the display unit 2 of Figs. 5 and 6, the shutter may be provided by forming the cover sheet 15 as an optical element having a controllable transmissivity, such as liquid crystal. Other types of optical shutter or mechanical shutter could be used.

The shutter is provided if the lighting is of a type which is difficult to quickly light and/or extinguish by controlling the power supply alone. For example, a gas discharge elements have been developed to maximise their efficiency and hence minimise power usage, but it remains difficult to precisely control the initiation and cessation of light emission. Illumination levels can have a significant rise or fall time. Also the driving voltage from a capacitor discharge cannot be instantaneously cut. This can make it difficult to limit the duration of the illumination. These problems may be avoided by use of the shutter. The illumination may be started by opening the shutter, having previously turned on the light and/or the illumination

may be ended by closing the shutter, with the light being turned off subsequently. The shutter may cut out the illumination during at least part of the rise or fall time in illumination levels so that illumination is only provided at a maximum level. The shutter is controlled by the control signal to open and close at the correct timings relative to the illumination.

Alternatively the display could allow the selective display of different images. For example plural images 1 could be printed on an endless roll arranged to be movable around a track defined by rollers to selectively position any one of the images 1 in a viewable position on the front face of the display unit 2, in the manner of a "scroller" used in stage lighting systems to change the colours of filters in front of lights.

Another alternative is for the front face of the display unit 2 to be constituted by an LCD display controllable to show a selectable image 1. This would have the advantage of avoiding the need to physically change mounted images. Preferably, but not essentially, the LCD display would be combined with backlighting as described above. Currently the cost of LCD displays would be prohibitive but the system is technically feasible and the cost is likely to reduce to an acceptable level.

Another alternative is to use a front-lit poster. However, it is preferable to use backlighting because in the unlit state a transparency reflects less ambient light and is darker than a poster, particularly outdoors. This means the unlit transparency will be less visible and will not affect the viewed image.

The images may instead be projected by an optical system from a small transparency onto the face of the display unit which acts as a screen. This has the advantages that no image at all is visible when the lighting is off and that the image may easily be changed. However an optical system of appropriate quality is expensive and it is difficult to obtain images of sufficient quality.

CLAIMS

1. An image display system comprising:

a series of images for disposal along the path of a vehicle;

lighting for briefly illuminating individual images; and

at least one control unit for controlling the lighting of at least one image to illuminate images successively as the vehicle passes, wherein the at least one control unit comprises:

detector means for detecting arrival of the vehicle;

means for deriving a measure of the speed of the vehicle;

means for controlling the lighting of said at least one image in response to detection of the marking to illuminate each individual image repeatedly for respective windows of the vehicle taking into account the speed of the vehicle and the positions of the respective windows of the vehicle.

2. An image display system according to claim 1, wherein the detector means is arranged to detect marking on the vehicle.

3. An image display system according to claim 2 wherein said means for deriving a measure of the speed of the vehicle is arranged to derive said measure of the speed from the output of the detector.

4. An image display system according to claim 2 or 3, wherein the marking encodes the positions of respective windows along the vehicle and the control unit includes means for decoding the output of the detector to derive the window positions.

5. An image display system according to claim 4, wherein the marking is a bar code.

6. An image display system according to claims 4 or 5, wherein the

decoding means is arranged to decode the output of the detector by looking up a memory table storing different sets of window positions.

7. An image display system according to any one of claims 1 to 3, wherein the control unit stores the positions of the respective windows of the vehicle.

8. An image display system according to any one of the preceding claims, wherein the control unit is arranged to detect a time difference in the output of said detector means as said measure of the speed of the vehicle.

9. An image display system according to claim 8, wherein the control unit is arranged to detect from the output of the detector means the time difference between two features of the marking a predetermined distance apart as said measure of the speed of the vehicle.

10. An image display system according to claim 9, wherein said two features are the beginning and end of the marking.

11. An image display system according to claim 8, wherein the detector means comprises two detector units a predetermined distance apart and the control unit is arranged to detect the time difference between the detection by the two units of the same feature of the marking.

12. An image display system according to any one of the preceding claims, wherein the control unit is arranged to control the lighting of a plurality of images taking into account the positions of the images.

13. An image display system according to claim 12, wherein in said control unit said respective window positions are represented by the individual bits of a first bit pattern which represent the presence or absence of a window at positions a predetermined spacing apart and said respective image positions are represented by

the individual bits of a second bit pattern which represent the presence or absence of images at positions said predetermined spacing apart, and said control unit is arranged to derive the timings for illumination of individual images in real time by relatively shifting the first and second bit patterns at a rate proportional to the derived speed of the vehicle and controlling the illumination of respective images when the bit of the second bit pattern representing the presence the respective image coincides with the bit of the first bit pattern representing the position of a window.

14. An image display system according to claim 13, wherein the control unit is arranged to shift said first bit pattern through a shift register and, using the second bit pattern map the bit positions of the shift register to said plurality of images, to output the bits at bit positions of the shift register where the second bit pattern indicates the presence of an image to control illumination of that image.

15. An image display system according to any one of the preceding claims, wherein the control unit further includes a source of electromagnetic radiation arranged to be incident on the vehicle such that the detector means receives the reflected radiation.

16. An image display system according to claim 15, wherein the electromagnetic radiation is infra-red radiation.

17. An image display system according to claim 16, wherein the source comprises an infra-red diode and the detector means comprises at least one matched infra-red receiver.

18. An image display system according to any one of the preceding claims, wherein the detector means is arranged to detect polarised light for detecting reflections from polarising markings.

19. An image display system according to any one of the preceding

claims in combination with the vehicle.

20. An image display system according to claim 19, wherein the vehicle comprises a plurality of linked carriages and has separate markings on different carriages.

21. An image display system according to any one of the preceding claims, wherein said means for controlling the lighting comprises a microprocessor programmed to derive illumination timings for an individual image.

22. An image display system according to any one of the preceding claims, wherein said means for deriving a measure of the speed of the vehicle comprises a counter chain.

23. An image display system according to any one of the preceding claims, wherein the at least one control unit is arranged to control the lighting to illuminate successive images at an identical position relative to each respective window.

24. An image display system according to any one of claims 1 to 22, wherein the at least one control unit is arranged to control the lighting to illuminate successive images at a gradually changing position relative to a respective window.

25. An image display system according to any one of claims 1 to 22, wherein the at least one control unit is arranged to control the lightly illuminate the images of respective portions of the series of images in positions which, relative to the vehicle, are different for subsequent portions.

26. An image display system according to any one of the preceding claims, wherein the images are backlit transparencies.

27. An image display system according to any one of the preceding claims, wherein the lighting comprises, for each image, at least one discharge lamp and a capacitive discharge circuit for lighting the at least one lamp, triggered by a control signal from said control unit.

28. An image display system according to any one of the preceding claims, further comprising means for attracting the attention of a viewer prior to the series of images.

29. A control unit for an image display system arranged to briefly illuminate successive images of a series of images disposed along the path of a vehicle as the vehicle passes, wherein the control unit comprises:

detector means for detecting arrival of the vehicle;

means for deriving a measure of the speed of the vehicle;

means for controlling the lighting of at least one image in response to detection of the marking to illuminate each individual image repeatedly for respective windows of the vehicle taking into account the speed of the vehicle and the positions of the respective windows of the vehicle.

30. A control means for an image display system for briefly illuminating successive images of a series of images disposed along the path of a vehicle as the vehicle passes, wherein the control means is arranged to control the lightly illuminate the images of respective portions of the series of images in positions which, relative to the vehicle, are different for subsequent portions.

31. An image display system comprising:

a series of images for disposal along the path of a vehicle;

lighting for briefly illuminating individual images; and

control means for controlling the lighting to illuminate images successively as the vehicle passes,

wherein the series of images comprises a plurality of cyclically interleaved

sequences of images.

32. An image display system according to claim 31, wherein the control means is arranged selectively to illuminate one of the sequences.

33. An image display system according to claim 31, wherein the control means is arranged to illuminate the images of all the sequences as the vehicle passes.

34. An image display system constructed and arranged to operate substantially as hereinbefore described with reference to the accompanying drawings.

35. A capacitive discharge circuit for a strobe lamp, comprising:
at least one discharge capacitor for storing charge;
a strobe lamp;
a trigger circuit arranged to trigger discharge of the at least one capacitor through the strobe lamp; and
a charging circuit for the at least one discharge capacitor arranged to charge the at least one discharge capacitor through an inductor in series with the at least one discharge capacitor.

36. A capacitive discharge circuit according to claim 35 , wherein the charging circuit includes a switch arranged to disconnect the at least one discharge capacitor from the charging circuit during discharge of the at least one discharge capacitor.

37. A capacitive discharge circuit according to claim 36, wherein the trigger signal applied to the trigger circuit is also supplied to the switch to control switching.

38. A capacitive discharge circuit according to claim 37, wherein the trigger signal is supplied to the switch through an optocoupler.

39. A capacitive discharge circuit according to claim 38, wherein the optocoupler is an opto-triac.

40. A capacitive discharge circuit according to any one of claims 35 to 39, wherein the charging circuit includes at least one reservoir capacitor having a capacitance greater than said at least one discharge capacitor connected in parallel with the series assembly of said at least one discharge capacitor and said inductor.

41. A capacitive discharge circuit according to claim 40, wherein said charging circuit further includes a resistor for limiting current flow to the at least one reservoir capacitor.

42. A capacitive discharge circuit according to any one of claims 35 to 41, wherein the charging circuit is supplied by a rectified AC supply.

43. A capacitive discharge circuit according to any one of claims 35 to 42, wherein the inductor is of a flourescent tube choke type.

44. A capacitive discharge circuit according to any one of claims 35 to 43, wherein the strobe lamp is a xenon discharge lamp.

45. A capacitive discharge circuit according to any one of claims 35 to 44, wherein the at least one discharge capacitor includes at least one main discharge capacitor and at least one attack capacitor having a lower capacitance than, and connected in parallel with, said at least one main discharge capacitor for increasing the speed of attack of the discharge.

46. A capacitive discharge circuit according to any one of claims 35 to 45, wherein a diode is provided between the charging circuit and the at least one discharge capacitor.

47. A capacitive discharge circuit constructed and arranged to operate substantially as hereinbefore described with reference to the accompanying drawings.

48. A display unit for mounting an image for display on the unit and for use in an image display system in which the image is briefly illuminated, wherein the display comprises:

lighting arranged to briefly illuminate the image; and

a shutter for controlling the duration of illumination provided by the lighting.

49. A display unit according to claim 48, wherein the shutter is an optical element having a controllable transmissivity.

50. A display unit according to claim 49, wherein the shutter is a liquid crystal shutter.

51. A display unit according to any one of claims 48 to 50, further comprising an optical system arranged to direct light from the lighting to a mounted image wherein the shutter is disposed between the lighting and the optical system.

52. A display unit according to any one of claims 48 to 51, wherein the optical system comprises a sheet arranged to receive light through an edge and to emit light through a major surface adjacent which a transparency constituting said image may be mounted.

53. A display unit according to claim 52, wherein said major surface of the sheet is etched to facilitate the emission of light.

54. A display unit according to any one of claims 48 to 54, wherein the shutter is disposed adjacent the image.

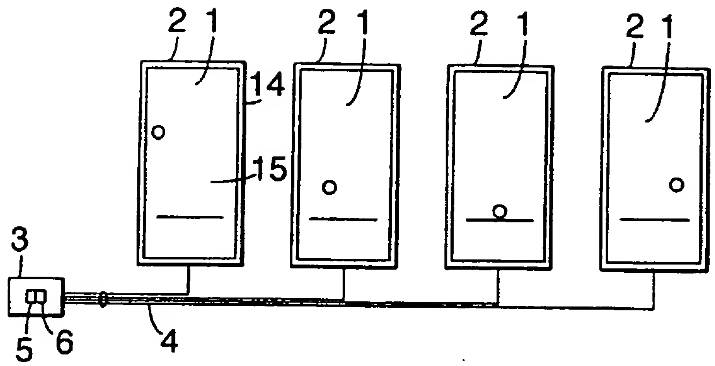
55. A display unit according to any one of the claims 48 to 54, wherein

the shutter is arranged to be closed before the illumination from the lighting ceases and/or to be opened after the illumination from the lighting commences for limiting the duration of the illumination.

56. A display unit according to claim 55, wherein the shutter cuts out illumination during at least part of the rise and/or fall in illumination levels from the lighting.

52. A display unit according to any one of the claims 43 to 51, wherein the lighting comprises at least one gas discharge element.

Fig.1.



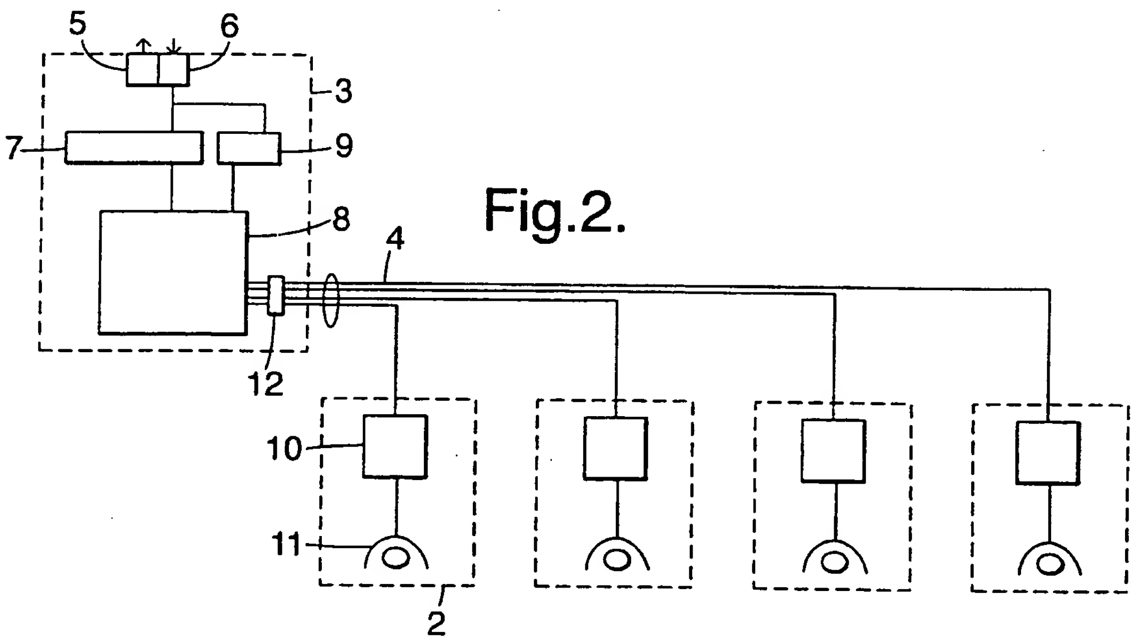
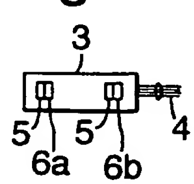


Fig.2.

Fig.3.



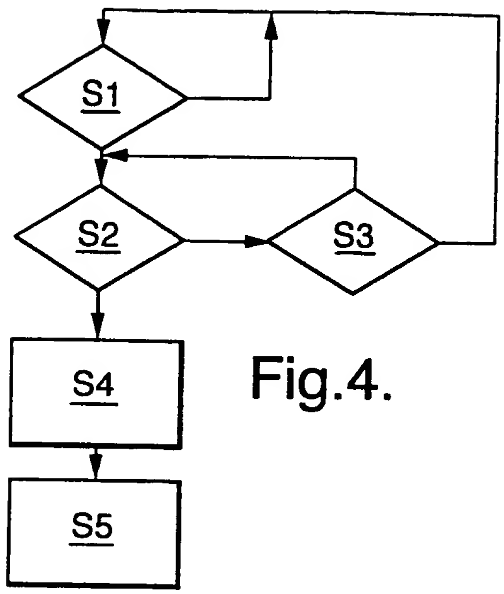


Fig.4.

Fig.5.

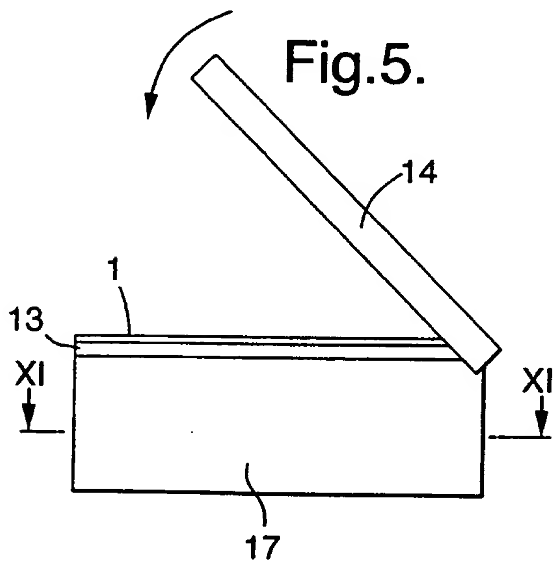
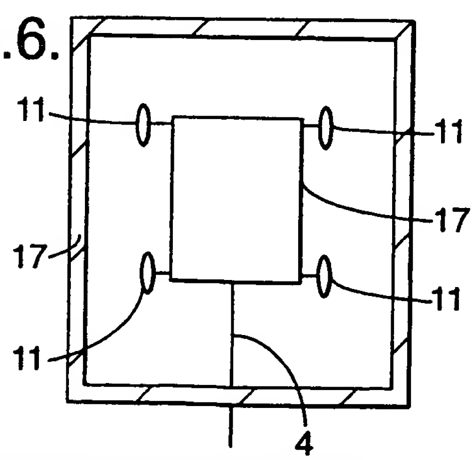
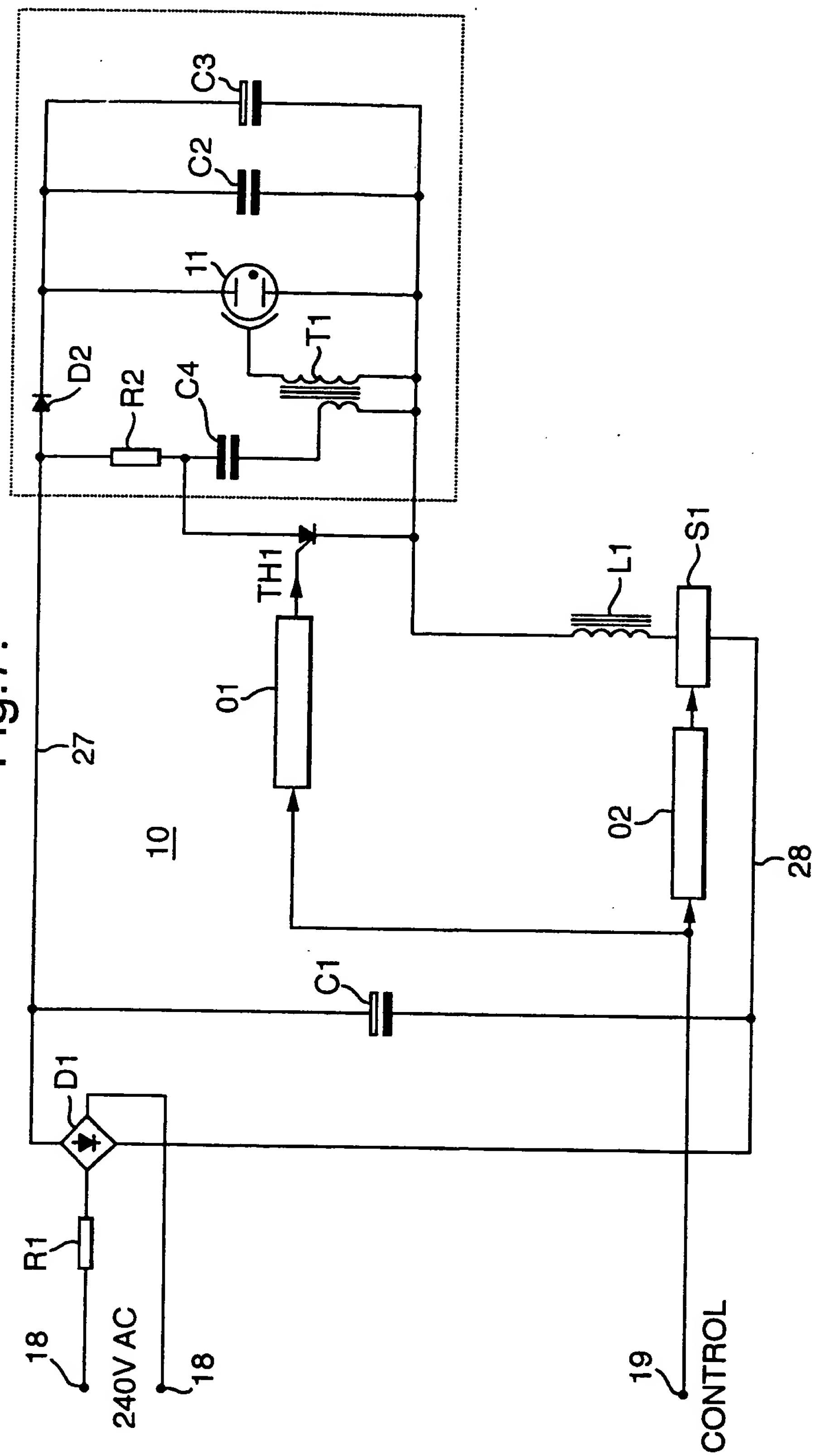


Fig.6.

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D1
R1
18
240V AC
18
19
CONTROL

Fig.7.

Fig.8.

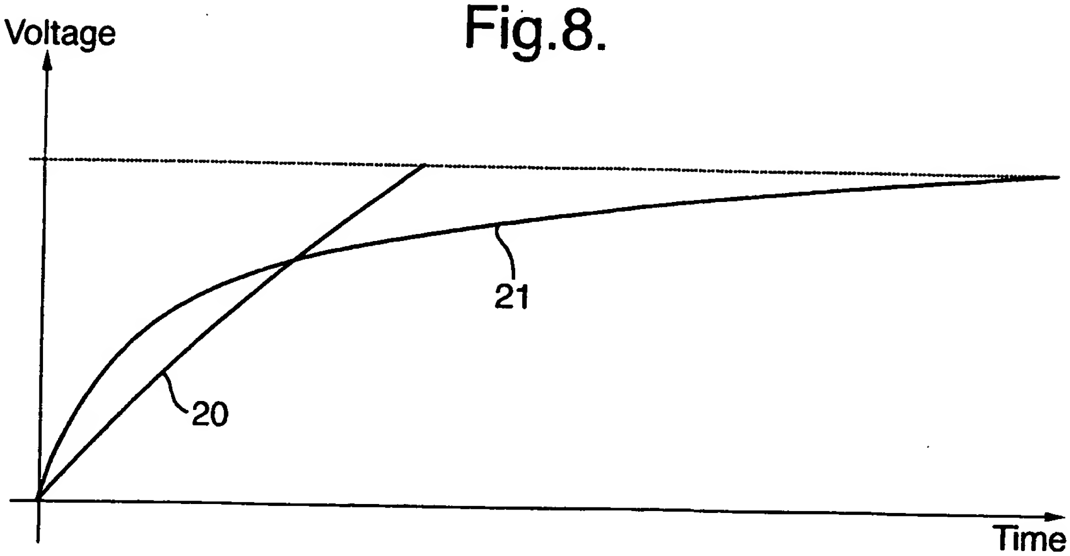


Fig.9.

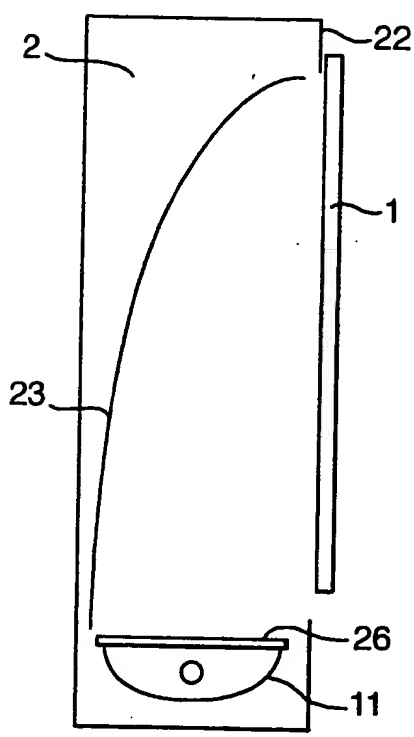
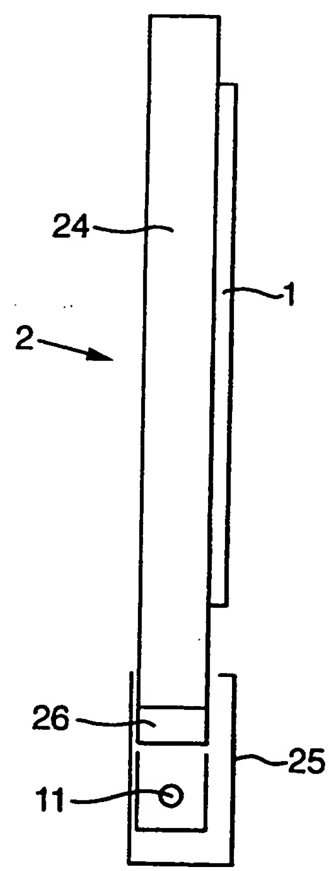


Fig.10.



INTERNATIONAL SEARCH REPORT

Inte   onal Application No
PCT/GB 00/00856

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G09F19/22 G03B25/00 G09F21/04 H05B41/19

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G09F G03B H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 31 05 820 A (HOCHBERG PETER;KEMPIS THOMAS) 26 August 1982 (1982-08-26) the whole document ---	1-4,8,9, 12, 15-17, 19-21, 23,27, 29, 31-34, 51-53,57

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
6 June 2000	14/06/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Pantoja Conde, A

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PCT/GB 00/00856

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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